Title: Virtual environment design as automated "physiological" counter-measures in extreme environment: from intensive care to human space flight.

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How can we model and design virtual environments to prevent, monitor and avoid automatically major human factors and health issues after intensive care long stay and long-term space flight?

Intensive care unit (ICU) and long-term space flight are extreme environments. In both cases it is a risky journey for patients or astronauts that requires life support systems to maintain and protect body integrity, vital functions, sensorimotor and cognitive capacity as stable as possible for post-ICU quality of life recovering or for human outer planet exploration.

To send and make a human living and acting in space, the problem is sensibly different. It is no longer a question of survival but of extension of the domain of life and activity of the person that requires specific life and activity support systems. Artefacts, transport and life modules, and wearable devices (astronaut suits) must be designed in order to maintain: body integrity and physiological functions; sensorimotor and cognitive functions, and the operational capacity of the operator in situation; the physiological functions of the operator in a functional area compatible with the return to planet gravity (different on earth, moon or mars) by avoiding for example the risk of cardiovascular collapse or a transient sensorimotor disability.

Designing reliable, safe and adaptable human-machine in intensive care for every person with a major disease is a challenge for automated monitoring, decision-making and medical treatment to maintain the patient alive and allow healing on one side and to avoid complications due to prolonged stay in intensive care. For example both long-bed rest in resuscitation and the absence of gravity during long-term space flights cause neuromuscular deconditioning and loss of muscle strength.

To prevent and avoid complications related to long-term stay in these extreme environment, related to human factors and habitability element as bed rest, sound and light environment, medical treatment side-effects in ICU, food or weightlessness and life support systems design, we propose the use of mutimodal virtual environment as “physiological” counter-measures and monitoring system.

The challenge of these human-system automated body enhancement system, is not so much a question of human-machine communication as of integrating the whole human machine into a coherent system ensuring functional capacity and limiting dysfunctions evolution either directly, either by countermeasure or substitution. It is a question of modelling and simulation correctness. From evidence-based medicine to model-based engineering it is a safety and reliability by design challenge.